National Aeronautics and Space Administration

RBI Instrument Overview

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RBI is a New Instrument Developed as a Follow-on to CERES Flown on TRMM, EOS, NPP, and JPSS-1

Clouds and the Earth's Radiant Energy System

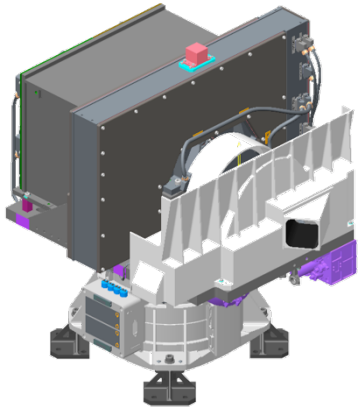
Radiation Budget Instrument (RBI)

Partnerships and Teams

- **NASA/ NOAA Partnership**
  - NOAA provides JPSS-2 satellite for accommodation of RBI
  - NASA provides RBI instrument and support through spacecraft I&T and launch/activation
  - NASA funds radiation budget science data analysis and generation of science products (RBM Project)
- **NASA Langley**
  - Manages prime contractor development of RBI instrument, provides management, technical, and mission assurance insight and oversight; provides support to spacecraft I&T thru launch and early on-orbit checkout (thru Phase D)
  - Hand-over and release of RBI instrument ownership by RBI Project occurs at the JPSS-2 Operational Hand-over Review (OHR). For Phase E, the Langley Science Directorate (SD) Radiation Budget Measurement (RBM) Project assumes responsibility for RBI for mission planning and operations
- **Harris Corp.**
  - RBI Instrument provider/prime contractor with sub-contractors providing key elements and support (SDL for Calibration, JPL for Thermopile Detectors, Sierra Nevada for Azimuth Rotation Module)
- **JPSS-2 Spacecraft and Mission Interface**
  - -- Interface Control (ICD & MICD) and Data Format

RBI scanning radiometer measuring three spectral bands at top of Atmosphere (TOA)

- Total 0.3 to > 50+μm
- Shortwave 0.3 to 5.0 μm
- Longwave 5.0 to 50+ μm



Science Goal

- To ***continue*** the measurements from the last two decades in support of global climate monitoring.
- RBI ***extends*** the Earth radiation budget measurements of the Earth Observing System (EOS) and Joint Polar Satellite System (JPSS)

- **Phase:** Formulation (B)
- **Risk:** 7120.5E, Category 2; 8705.4 Payload Risk Class B
- **Flight Instrument Delivery:** March 2019
- **JPPS-2 On-dock Delivery Date:** April 2019
- **Life:** 7 years

RBI Baseline and Threshold Requirements

Clouds and the Earth's Radiant Energy System

Key Performance Requirements	Baseline Science Requirements	Threshold Science Requirements
Total Spectral Range	0.3 to 100+ microns	0.3 to 50+ microns
Shortwave Spectral Range	0.3 to 5 microns	0.3 to 5 microns
Longwave Spectral Range	5 to 50+ microns	5 to 35+ microns
Total Channel Absolute Radiometric Accuracy	≤ Larger of 0.575 W/m^2-sr or 0.5% (k = 1)	≤ Larger of 0.575 W/m^2-sr or 0.75% (k = 1)
Shortwave Channel Absolute Radiometric Accuracy	≤ Larger of 0.75 W/m^2-sr or 1.0% (k = 1)	≤ Larger of 0.75 W/m^2-sr or 1.25% (k = 1)
Longwave Channel Absolute Radiometric Accuracy	≤ Larger of 0.575 W/m^2-sr or 0.5% (k = 1)	≤ Larger of 0.575 W/m^2-sr or 0.75% (k = 1)
Total Channel Radiometric Precision	≤ 0.2 W/m^2-sr + 0.1% (k = 3)	≤ 0.2 W/m^2-sr + 0.1% (k = 2)
Shortwave Channel Radiometric Precision	≤ 0.2 W/m^2-sr + 0.1% (k = 3)	≤ 0.2 W/m^2-sr + 0.1% (k = 2)
Longwave Channel Radiometric Precision	≤ 0.2 W/m^2-sr + 0.1% (k = 3)	≤ 0.2 W/m^2-sr + 0.1% (k = 2)
Total Channel Linearity	≤ 1.5 W/m^2-sr	≤ 2.5 W/m^2-sr
Shortwave Channel Linearity	≤ 1.28 W/m^2-sr	≤ 2.13 W/m^2-sr
Longwave Channel Linearity	≤ 0.54 W/m^2-sr	≤ 0.9 W/m^2-sr
Point Spread Function	Within 95% of CERES	Within 90% of CERES

RBI Baseline Science Requirements Match CERES

RBI Accommodated on JPSS-2 Spacecraft Nadir Deck

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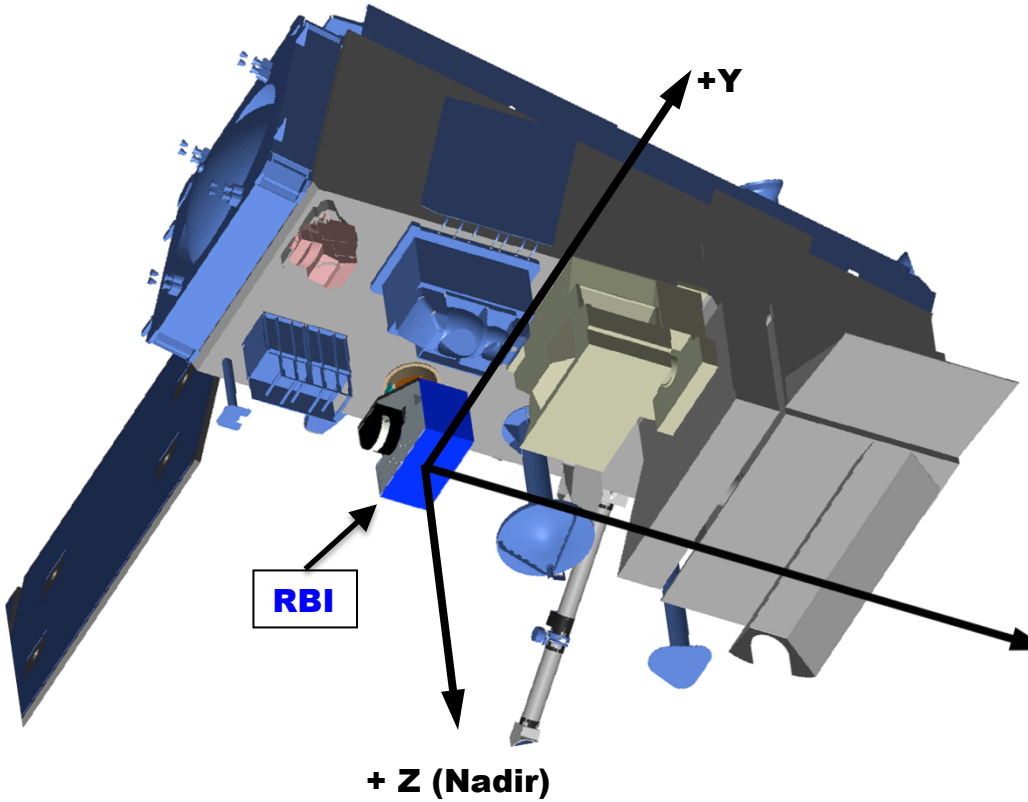


JPSS-2 Instrument Complement

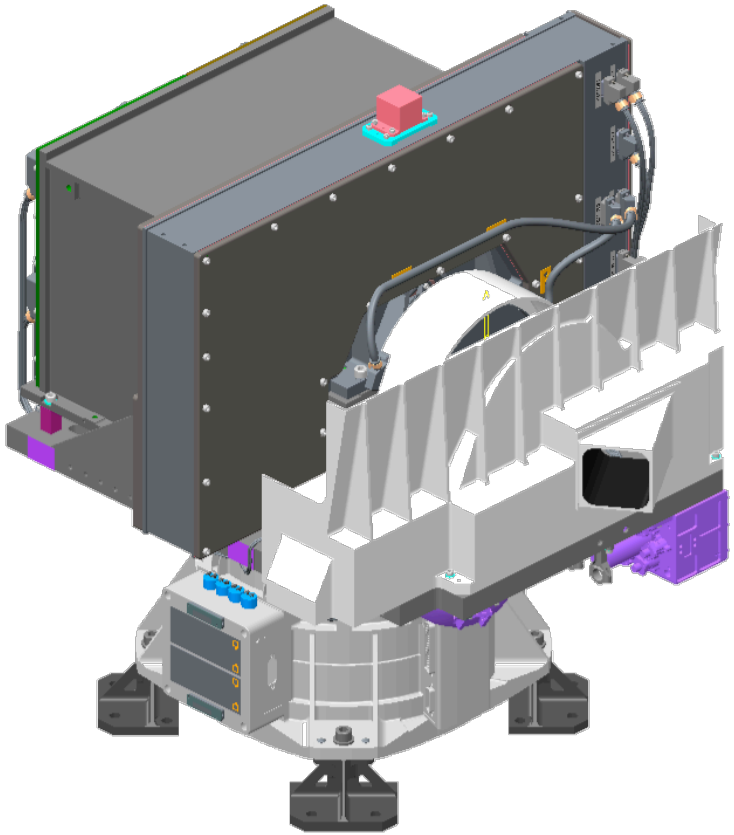
- Radiation Budget Instrument (RBI)
- Advanced Technology Microwave Sounder (ATMS)
- Cross-track Infrared Sounder (CrIS)
- Visible Infrared Imagining Radiometer Suite (VIIRS)
- Ozone Mapping and Profiler Suite (OMPS)

JPSS-2 Observatory

- Nominal Altitude: 824 km ± 17 km
- Ground Track Repeatability Accuracy: ±20 km at the equator
- Ground Track Repeat Cycle: <20 days
- Nominal Ascending Equator Crossing Time: 1330 (local time) ± 10 min

Spacecraft design and Instrument locations are notional and representative of JPSS-1
JPSS-2 configuration has not been determined

RBI is a New Instrument Developed as a Follow-on to CERES Flown on TRMM, EOS, NPP, and JPSS-1



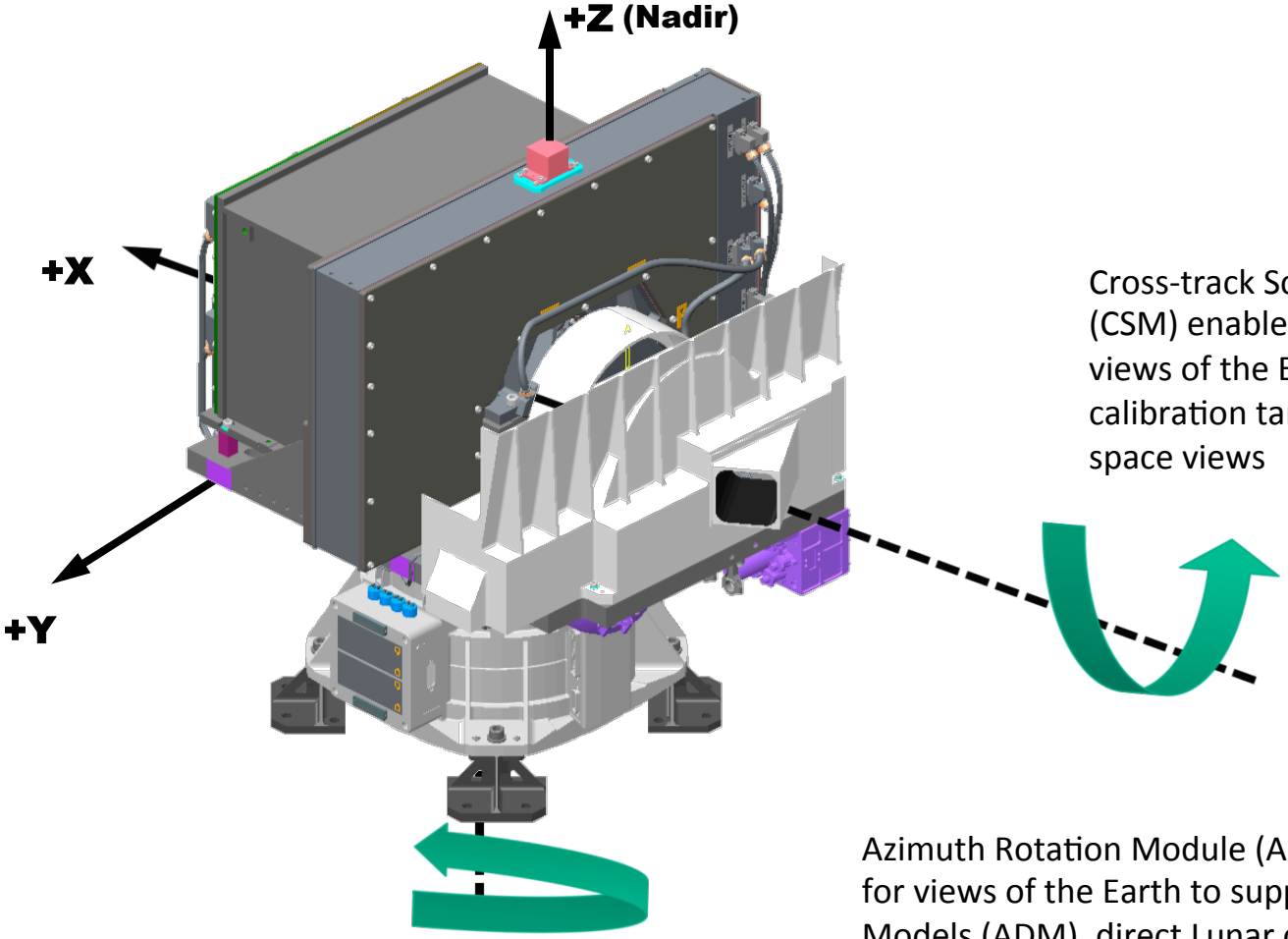
Instrument Description:

- A Three-Channel three-telescope broadband scanning radiometer designed to measure the solar reflected and Earth emitted thermal radiation at the top of the atmosphere
- Electrically redundant design to meet Level 1 life and reliability (7 years at 85%)
- Utilizes one Infrared Calibration Target (ICT), one Visible Calibration Target (VCT), one Solar Calibration Target (SCT), space views, and Lunar views as flight calibration sources
- Each telescope utilizes redundant thermopile detectors

Characteristics:

- Spectral Range: ~ 320 nm – 100 microns
- Field of View (FOV): ~1.3 x 2.6 degrees
  - ~19 x 37 km at nadir
- Data Interface: MIL-STD-1553
  - <300 kb/sec (Average) / <400 kb/sec (Peak)
- Instrument including redundant electronics
  - Mass: ~68 kg (CBE) 80 kg (allocation)
  - Power: ~66 W (Cross-track mode)
- Envelope: ~815x640x375 (circular) cm^3

Field of Regard Obtained by Mounting Orientation & Two-Axis Pointing



Cross-track Scan Module (CSM) enables swath mode views of the Earth, internal calibration targets, and space views

Azimuth Rotation Module (ARM) enables biaxial-mode for views of the Earth to support Angular Distribution Models (ADM), direct Lunar calibration, and indirect Solar calibration using the Solar Calibration Target (SCT)

RBI Continues CERES Operational Scanning Capabilities

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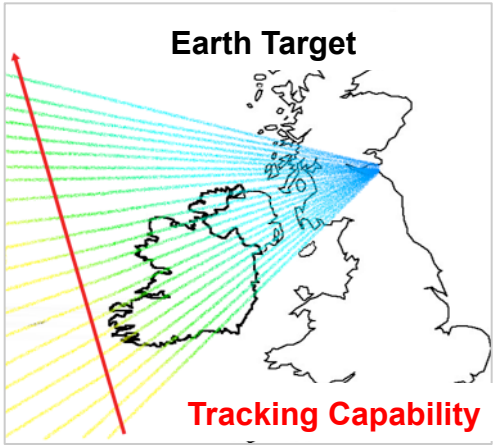
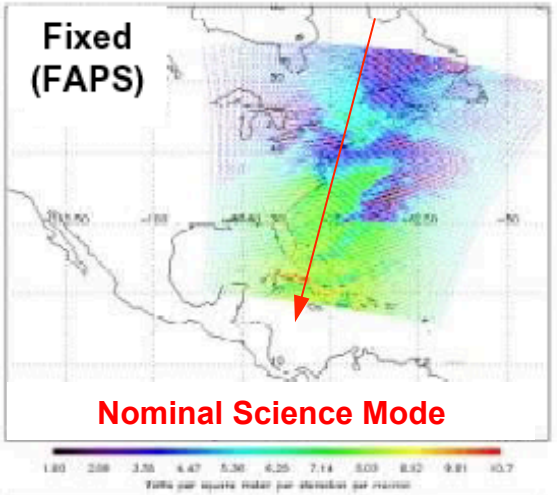
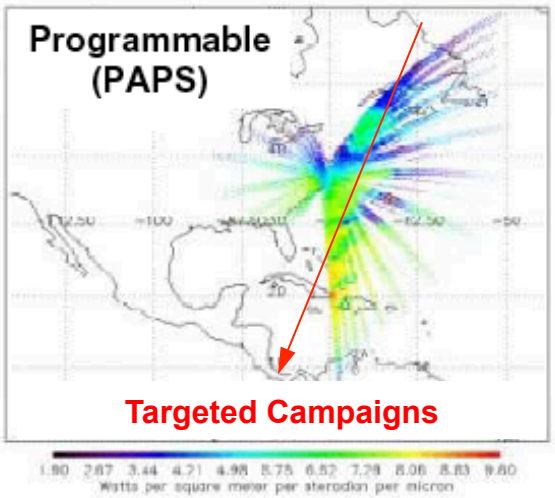
Enabling Inter-mission Continuity

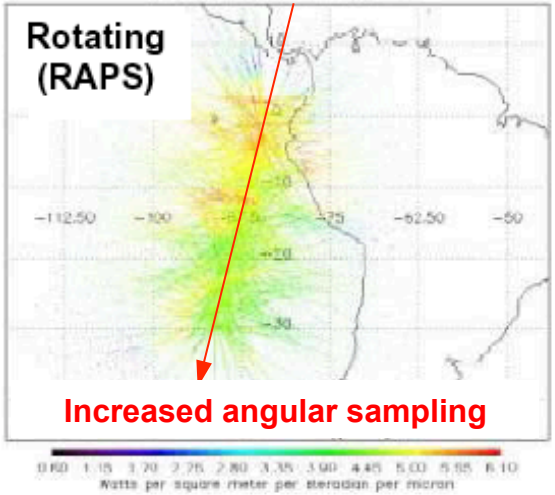




Fixed Azimuth Plane Scan

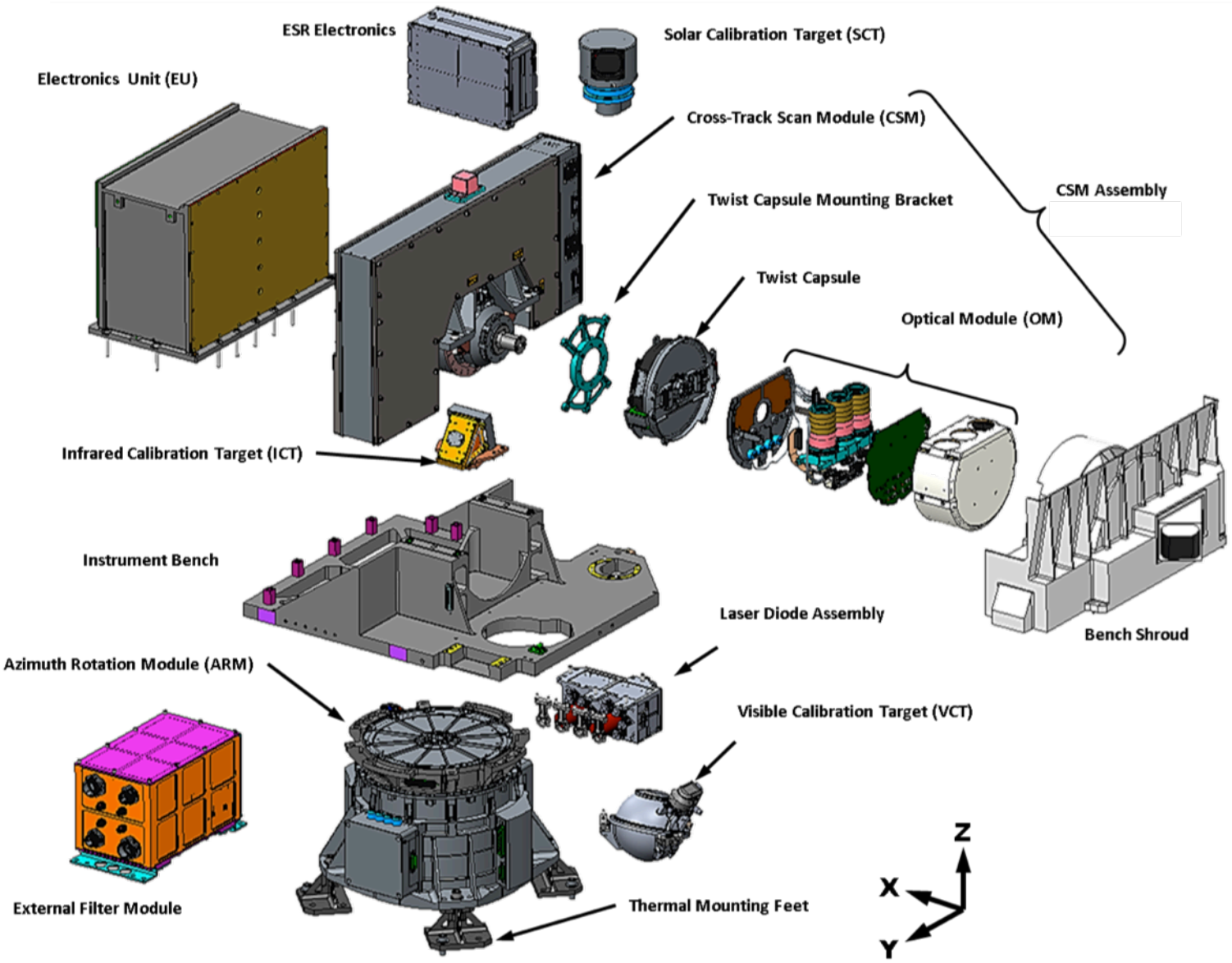
Programmable Azimuth Plane Scan





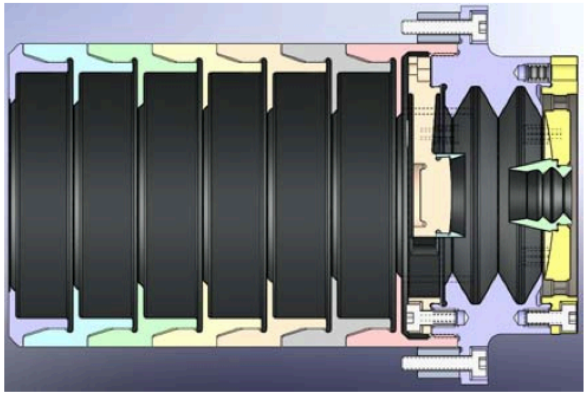
Rotating Azimuth Plane Scan

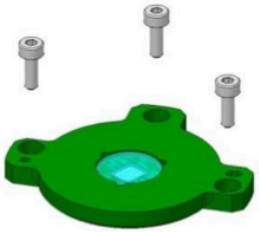
Major RBI Sensor Modules and Subsystems

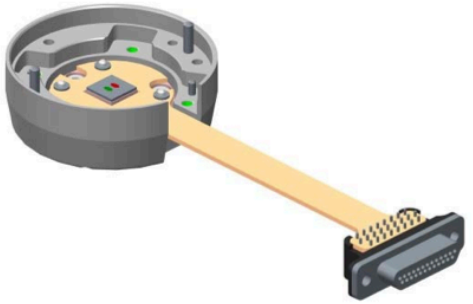


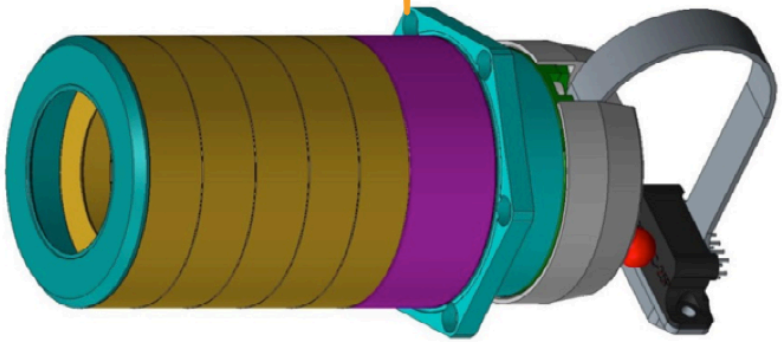
Cassegrain Optical System similar to CERES

Radiance in → **Fore Baffle** → **Telescope** *Includes Primary & Secondary Baffles* → **Spectral Filter** *SW and LW* → **Detector** → Electrical signal out









Near-Term Activities

Completed Activities

- 5/14/14: RBI contract Awarded to Exelis
- 12/10/14: System Requirements Review (SRR) completed
- 6/9/15: Gov't issued a stop work order and Cure Letter
- 8/21/15: Harris given approval to resume work on RBI
- 1/13/16: Delta System Requirements Review (DSRR)
- 3/29/16: Key Decision Point B (KDP-B)

Upcoming Activities

- 5/10-12/16: Preliminary Design Review (PDR)
- 5/17/16: Programmatic Baseline Review
- 6/17/16: Key Decision Point C (KDP-C)
- 6/15/17: Critical Design Review (CDR)
- 3/30/19: Instrument Delivery